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Reneman, Michiel; Helmus, Miriam

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Interinstrument reliability of the RT3 accelerometer

Michiel Reneman^{a,b} and Miriam Helmus^{a,b}

The objective of this study was to assess the interinstrument reliability of six RT3 accelerometers for measuring physical activities. Each of the six healthy participants, mean age 36.1 years (SD 9.4), carried six RT3 accelerometers (same type and same producer) simultaneously placed ventrally at the waist belt. The participants performed three standardized activities: walking on a treadmill at 3.0 km/h and 5.0 km/h, and sitting on a chair. Each activity lasted 5 min. The recordings of the accelerometers were compared with each other to assess interinstrument reliability. A correlation of 0.75 or higher was interpreted as sufficient. The mean Pearson correlation between the six accelerometers was $r = 0.78$ (0.46–0.97). The intraclass correlation between the accelerometers was 0.75 (95% confidence interval: 0.46–0.95, $P < 0.01$). In conclusion, the interinstrument reliability of the RT3 accelerometer is sufficient. However,

the lower limit of the confidence interval is low, indicating a challenge to the reliability. *International Journal of Rehabilitation Research* 33:178–179 © 2010 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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Keywords: accelerometry, clinimetry, consistency, healthy participants, movement intensity, reproducibility

^aCenter for Rehabilitation and ^bGraduate School for Health Research, University Medical Center Groningen, University of Groningen, The Netherlands

Correspondence to Dr Michiel Reneman, PhD, Center for Rehabilitation, University Medical Center Groningen, University of Groningen, PO Box 30002, 9750 RA Haren, The Netherlands
Tel: +31 50 5338550; e-mail: m.reneman@cvr.umcg.nl

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Introduction

Assessment of the intensity and patterns of movement behavior is important for the design and evaluation of effectiveness of interventions (Rowlands *et al.*, 2004). Diaries are frequently used instruments for measuring movement behavior. Diaries are practical and inexpensive, but do not provide objective data. Objective instruments to measure movement behavior are gaining support (Ward *et al.*, 2005; Verbunt *et al.*, 2009). Accelerometry is a method to objectify movement behavior with a minimum of effort for the user. Like any instrument, an accelerometer must demonstrate reliability as a minimum requirement. Interinstrument reliability, referring to the reproducibility of the measurement across devices, has been demonstrated in research using a vibrating platform (Powell *et al.*, 2003). The interinstrument reliability, however, has only scarcely been tested *in vivo* (Powell and Rowlands, 2004). In this study, the interinstrument reliability of six RT3 accelerometers was tested during standardized physical activities.

Methods

Procedures

The participants performed three standardized activities in the same order: walking on a treadmill at 3.0 km/h and 5.0 km/h, and sitting on a chair. While sitting, participants were allowed to move their upper body and arms. Each activity lasted 5 min with 1 min of rest between activities. The start and finish of each activity were timed and recorded. Each participant carried six RT3 accelerometers simultaneously at the waist belt; three accelerometers left of the center and three accelerometers

right of the center. The order of the six accelerometers was different for each participant to prevent systematic 'placement-error' (123456, 234561, 345612, etc). The accelerometers were activated before the start of the first activity of the first participant. Data were transferred to the personal computer immediately after termination of the third activity of the sixth participant.

Participants

In this research, six healthy participants participated voluntarily. The group consisted of three men and three women, mean age 36.1 years (SD 9.4). Inclusion criteria were participant declared to be in good health and to participate voluntarily. All participants filled in the Physical Activity Readiness Questionnaire, as a safety criterion.

Instrument

The RT3 accelerometer (Stayhealthy Inc., Monrovia, California, USA) is a small ($71 \times 56 \times 28$ mm, 65.2 g) measuring device that works on two AA batteries. Depending on the setting, the device can store data for a maximum of 21 days. The data are transferred to a personal computer, analyzed and presented in a table or graph. The sensor in the RT3 accelerometer measures in three directions of movement (X, Y, and Z), reflecting the vertical, anteroposterior, and mediolaterale axis. Any movement of the sensor is measured and stored as an 'activity count' (Rowlands *et al.*, 2004). In this study, we used six RT3 accelerometers that were bought in 2005 directly from the manufacturer.

Data analysis

The raw data (counts) of the RT3 accelerometers were read with the software provided by the manufacturer. The data were presented in counts/min. Of each participant, a registration of a total of 17 min was recorded (3×5 min per activity, and 2×1 min between activities). The average vector of the X, Y, Z axes was taken as an outcome measure (V_m). Of each recording period of 17 min, the mean V_m was used for analyses. Data were not filtered. Pearson correlation coefficients were calculated to analyze relations between accelerometers. The intraclass correlation coefficient (ICC; two-way random model for absolute agreement), was calculated to analyze interinstrument reliability. The ICC is a measure to express the consistency and the agreement of data. ICC can vary from 0.00 to 1.00. ICC values of 0.75 and higher were interpreted as sufficient reliability, values from 0.50 to 0.74 were interpreted as moderate reliability, and values under 0.50 as poor reliability (Portney and Watkins, 2000). Statistics were computed with the use of the Statistical package for Social Sciences, Version 14 (SPSS Inc., Chicago, Illinois, USA).

Results

Results of the correlation analysis are presented in Table 1. The ICC between the six RT3 accelerometers was $r = 0.75$ [95% confidence interval (CI): 0.46–0.95, $P < 0.01$]. The lower limit of the ICCs was below 0.50, indicating poor reliability. One of the accelerometers seemed to provide discarding results (accelerometer number 5). When this accelerometer was excluded, then $ICC = 0.80$ (95% CI: 0.52–0.95, $P < 0.01$). The lower limit of the ICC was now higher than 0.50, indicating moderate reliability. The mean correlation between the remaining five RT3 accelerometers was $r = 0.78$ (lowest $r = 0.74$, highest $r = 0.97$).

Discussion

The objective of this research was to assess the interinstrument reliability of the RT3 accelerometer. The result between six accelerometers was $ICC = 0.75$, indicating good reliability. The lower limit of the 95% CI of the ICC, however, was below 0.50. It seemed that one of the accelerometers (in this study number 5) provided inconsistent readings. As a group, however, the results of this study indicate that the interinstrument reliability of the RT3 accelerometer is sufficient. As one of the accelerometers provided less consistent readings, it may

Table 1 Mean (SD) amount of counts and Pearson correlation coefficients between six accelerometers

Accelerometer	Counts		ICC					Item total correlation
	Mean	SD	1	2	3	4	5	
1	11 689	1550						0.79
2	11 798	1570	0.84					0.92
3	11 753	1172	0.75	0.80				0.88
4	10 450	1063	0.74	0.79	0.97			0.91
5	11 438	964	0.46	0.74	0.66	0.73		0.72
6	11 877	1186	0.78	0.95	0.83	0.89	0.80	0.95

ICC, intraclass correlation.

be relevant to assess reliability of the individual instruments, especially when used for individual clients. The methodology as described in this study can be used in a clinical environment. Clinics should possess two or more accelerometers to be able to do this. We are unaware of more efficient means of testing interinstrument reliability *in vivo*. As demonstrated by others (Powell and Rowlands, 2004; Rowlands *et al.*, 2007), the sample size of this study ($n = 6$ participants and $n = 6$ accelerometers) seemed sufficient for a reliability study. For studies aiming to assess the validity of accelerometers, however, larger sample sizes are recommended. Data collected from healthy participants may not be generalizable to patients. For testing validity of the instruments, it may thus be necessary to test on specific patient groups separately.

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